TECHNICAL NOTES

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Soil Freezing Observations After Changes in Forest Cover

The presence and depth of concretely frozen soil over extensive areas can have serious hydrologic effects. Concrete frost is a very dense type of frost in which soil particles are cemented together by frozen ice crystals or lenses. It is almost impermeable to the passage of water, thus posing a serious threat to recharge of soil-moisture deficits and ground-water tables during early spring snowmelt. In hilly areas it can cause overland runoff which contributes to spring floods.

Forest cover influences the formation of concrete frost in a number of ways. It affects the depth of the insulating blanket of snow on the ground, the type and depth of humus formed, and the amount of heat reaching the forest floor. A change in forest cover can alter each of these factors.

Differences in soil freezing after forest conversion were observed during the late winter and early spring of 1957 and 1958 at the Pike Bay Experimental Forest near Cass Lake, Minn. Part of a large area of brush and inferior aspen had been converted to red pine in 1937. Prior to planting, the area had been cleared of hardwoods, plowed, and disked. In 1956 the pine plantation supported 94 square feet of basal area per acre, and the adjacent original stand supported 54 square feet of basal area per acre. The soil under each stand was classified as a Nebish loamy fine sand over a heavy clay loam.

Ten frost observations in each area were taken on the dates indicated in table 1. Frost was identified by chopping small pits, and depth of freezing was measured with a penetrometer.

In both years concrete frost was deeper and remained longer in the spring in the pine plantation than in the nearby aspen-brush area. Over the 2-year period concrete frost was observed at 76 percent of the sampling points in the plantation and at 57 percent of the points in the aspen-brush area.

Variations in humus type and depth and snowpack depth help explain the differences in frost penetration. Under the aspen-brush stand a duff-mull type humus was found with an average depth of 3.3 inches and some organic matter incorporated in the mineral soil. A mor humus developed under the plantation. It averaged only 1.5 inches in thickness with almost no organic material incorporated in the mineral soil. Early winter snow depths averaged 1.7 inches deeper in the aspen-brush stand. Below-normal temperatures and an extremely light snowpack were probably responsible for deeper frost penetration during the winter of 1958.

Table 1.--Depth and occurrence of concrete frost under a red pine plantation and an aspen-brush stand

Sampling date	Red pine plantation: Average frost depth 1/	Red pine plantation: Occurrence of frost	Aspen-brush stand: Average frost depth 1/	Aspen-brush stand: Occurrence of frost
	Inches	Percent	Inches	Percent
1957				
February 5	4.6	80	3.0	90
19	3.6	100	3.0	100
March 4	7.7	80	4.2	100
22	6.6	90	3.3	90
28	10 +	100	3.9	90
April 4	3.4	40	2.8	80
11	2.6	20	1.2	30
17	1.0	20	0	0
1958				
March 17	10 +	100	6.5	100
28	10 +	100	6.7	100
April 2	10 +	100	2.7	60
9	10 +	100	.7	20
15	10 +	100	0	0
18	10 +	90	0	0
23	.9	20	0	0

1/ Total frost depth divided by total number of observations, where zero is a valid observation. Frost depths beyond 10 inches were recorded as 10 +.

Measurements of snowmelt characteristics under the two stands indicate snow remained longer under the red pine plantation. On the last date frost was found in 1957 the snowpack averaged 10.8 inches deep and contained 3.2 inches of water under the pine. In the adjacent aspen-brush area average snow depth was only 6.6 inches with a moisture content of 2.0 inches. Thus, in a normal snowpack year the disadvantages of deeper and longer lasting soil freezing under the plantation were offset by delayed melting of snow. This was not true for 1958, however, when the below-normal snowpack disappeared by early March. Under these circumstances delayed thawing of frozen soil under the plantation would seriously affect infiltration of early spring rains.

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